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### Cartridge

The invention refers to a cartridge adapted for insertion into a cartridge-seat that communicates with a low-pressure chamber, such as in a shell case and, specifically, a reusable shell case. More precisely, the invention refers to a propellant cartridge having a replaceable restriction that, upon charging or recharging the cartridge using conventional recharging tools, may be adapted to various powder charges in order to ensure a complete combustion of the entire powder charge.

Propellant cartridges are used in various connections, such as in weaponry for expulsion of projectiles or in industrial applications to achieve mechanical results. The propellant cartridge usually comprises a propellant formed by a powder charge enclosed by a cylinder sleeve, and a detonator that is sensitive to mechanical impulse fitted into the rear end of the sleeve effective for firing the propellant. The forward end of the cartridge is usually sealed through a star-crimp.

In some applications there is a desire to control combustion pressure and exit velocity. One example of these applications is the expelling of 40 mm projectiles from shell cases, wherein different exit velocities in the order of 50-300 m/sec may be desired for different types of projectiles. In this connection, a comparatively smaller powder charge is commonly used to achieve low velocities. However, since the inner volume of the shell case is large in relation to the powder charge, the combustion may be incomplete as a result of an unfavorable low pressure and low temperature, leading to irregular exit velocities for the same projectile.

As a solution to this problem, shell cases are known to be formed with a low-pressure chamber having a comparatively large volume wherein the combustion gases are allowed to expand to a pressure that results in a desired exit velocity for the projectile. In order to avoid uneven or incomplete combustion of the propellant at unfavorable pressure and temperature within the larger low-pressure chamber,

the powder charge is ignited inside a high-pressure chamber having a comparatively smaller volume and communicating with the low-pressure chamber via a gas exhaust channel. The propellant cartridge may be equipped with a membrane adapted to be ruptured only when sufficient pressure, i.e. a pressure needed for a complete combustion of the powder charge, is produced by the burning propellant. Combustion gases will then flow through the ruptured membrane and into the low-pressure chamber, where the gas expands to a suitable lower pressure acting against the rear end plane of the projectile, for expelling the same at the intended velocity.

A reusable shell case having a high-pressure chamber and a low-pressure chamber is disclosed in WO 01/81854 A1. In this shell case, which is separable having a dismountable rear portion that receives a propellant cartridge in a cartridge-seat forming a high-pressure chamber, the connection between high-pressure and low-pressure chambers is formed by a gas exhaust channel acting as a constriction which is sized to provide a pressure in the high-pressure chamber that is favorable for a complete combustion of the powder. This reusable shell case contains no deformable details that must be replaced upon recharging, except for the used propellant cartridge, for which reason the shell case is particularly suitable for repeated recharge and firing.

Another example of prior art is US 6,041,712 which discloses a shell case having a high-pressure chamber and a low-pressure chamber connected through a gas exhaust channel acting as a constriction. In one embodiment, the channel is formed in a front wall of a cartridge-seat that is formed integrally in the case, in another embodiment the channel is formed in a front wall of a sleeve adapted for protecting the propellant cartridge against the high pressures that are generated in this connection. In order to achieve a desired high pressure, a membrane or a plug of material is arranged in the propellant cartridge and dimensioned to be ruptured at a predetermined pressure.

Drive pressure and exit velocity may be varied and adapted to different projectiles primarily by dimensioning the size of the powder charge, or by choosing a powder with respect to its properties such as burning speed, for example. A static constriction of the connection between high-pressure and low-pressure chambers in a re-

chargeable device may be limiting for the possibility to control the projectile's exit velocity, particularly when a low velocity is desired, since a static constriction will be optimized only for a propellant charge of a certain size.

The invention aims to solve the above mentioned problem by providing a cartridge that by itself operates as a high-pressure chamber without being dependent on the shell case for generating the pressure and temperature required for a complete and perfect combustion of the powder charge. This object also includes the provision of a cartridge that is readily adaptable to differently sized propellant charges upon recharging by use of conventional reloading tools.

These objects are met in a propellant cartridge as defined by the characterizing features of claim 1. Advantageous embodiments of the cartridge are defined in the subordinated claims.

Briefly, the objects of the invention are met in a cartridge equipped with a separate and exchangeable insert formed with a passage going there through and acting as a constriction which delays the passage of combustion gases exhausted from the cartridge. The insert has an outer diameter adapted to the inside diameter of the cartridge in order to be depressed into the cartridge similar to a bullet of adequate caliber, by use of conventional reloading tools.

Alternatively, the insert may be combined with a stemming covering the passage at the inner or outer end of the insert. The purpose of such a stemming is primarily to protect the powder charge, though it may alternatively be dimensioned to be ruptured by a predetermined gas pressure, similar to the prior art membranes.

Further details, properties and advantages achievable from the present invention will be more fully described below by reference to the accompanying, diagrammatic drawings by which

Fig. 1 shows one embodiment of a propellant cartridge according to the invention, and

Fig. 2 shows the propellant cartridge according to the invention applied in a divisible shell case.

In the drawings, figs. 1 and 2 show a propellant cartridge 1 shaped as a cylindrical container having a primer 2 received in its rear end, and a propellant charge 3, such as a powder charge 3, received in the container-shaped portion. As illustrated in the drawings, the cartridge 1 is adapted for insertion into a cartridge seat 4 shaped as a cylindrical chamber having an open rear end, and which has a wall 5 in its opposite, forward end. The cartridge-seat 4 communicates with a low-pressure chamber 6 formed in a shell case as illustrated in the drawings, or alternatively in any other type of expulsion device. In fig. 1, the connection between cartridge-seat and low-pressure chamber is formed as a central opening through the wall 5.

The diameter of a gas exhaust passage between the high-pressure chamber and the low-pressure chamber is critical in respect of ensuring a proper pressure and temperature for the complete and perfect combustion of a propellant charge that is sized to control the exit velocity of the subject projectile P. A fixed diameter of this gas exhaust passage restricts the possibility of achieving constant exit velocities, particularly within a lower velocity range.

Through the measures suggested in the present invention, the passage I between high- and low-pressure chambers is no longer decisive for the control of exit velocities by sizing the powder charge or by the choice of powder properties.

In the front end of the cartridge 1, a separate and exchangeable insert 7 is inserted. Said insert covers the section of the cartridge and has a passage 8 going there through, through which passage the combustion gas exits from the cartridge. The passage 8 connects the low-pressure chamber 6 to the inner volume of the cartridge, and may have a length sufficient to reach through the front wall 5 of the cartridge-seat in order to mouth in the low-pressure chamber, as in the shown embodiment. The insert 7 is cylindrical, having a portion 9 inserted into the container portion of the cartridge, the diameter of which is adapted to seal against the cylindrical wall of the cartridge container portion. A front end of the insert 7 is formed with a shoulder 10. The shoulder 10 has a radial extension and connects the portion 9, which is inserted into the cartridge, to a portion 11 of less diameter extend-

ing from the cartridge and received by the opening I when the cartridge is seated in the cartridge-seat.

The shoulder 10 is shaped and adapted to be forced into sealing contact with the front wall 5 of the cartridge-seat upon ignition of the powder charge. To this purpose, the insert 7 preferably is made of a material having less hardness than the material of the cartridge-seat in order to allow for a slight deformation in the surface of the shoulder 10. This way will be secured a sealing contact that prevents combustion gases from leaking past the envelope surface of the insert 7. Preferably, the insert 7 is made of metal or light metal, such as aluminum, copper or copper alloy.

The passage 8 is dimensioned in respect of the powder charge size, the desired expulsion pressure and exit velocity, and operates like a constriction that delays the flow of combustion gases into the low-pressure chamber whereby a pressure that is sufficient for a complete combustion is built up in the cartridge. The passage may be designed to mouth in the low-pressure chamber as illustrated in the shown embodiment, or designed to mouth in the opening through the front wall 5. Alternatively, the passage 8 may also be formed with radially oriented openings and a closed forward end (not shown). Adaptation of the passage particularly involves the dimensioning of the passage's cross sectional area, and may include as well the sizing of its axial length, the length of the insert, and the available volume of the cartridge that is related to the depth by which the insert is inserted in the cartridge. The passage 8 may also be shaped different from what is illustrated here, and need not have a continuous section throughout its axial length. Further, one or several sealing elements may be arranged at the inner end or at the outer end of the insert 7, in order to seal the passage and adapted to be ruptured by ignition of the powder charge.

In fig. 1, a membrane 12 is shown in broken lines to rest towards the inner end of the insert and covering the passage 8. The membrane 12 may be designed and dimensioned to be ruptured by a predetermined pressure. The membrane 12 may, for example, be made of synthetic material or metal, and may be formed with indication of fracture where appropriate. In the case of a membrane 12, the dimensioning of the passage 8 is less critical for building up a desired pressure in the cartridge 1.

However, the passage and membrane may be dimensioned in combination to secure the necessary pressure within the cartridge.

With reference to fig. 2, a propellant cartridge 1 according to the invention is shown to be mounted in a divisible shell case 13, a shell case known per se from WO 01/81854 A1. This shell case has a dismountable rear portion 14 having a through hole 15. The rear portion 14 is shown being connected to a front portion 16 by means of a threaded connection. A portion 17 formed with a reduced diameter in the rear end of the cartridge 1 is received through the hole 15. A primer 2 is mounted in said reduced diameter portion, the primer substantially leveling with a rear end plane 18 of the dismountable rear portion of the shell case when the cartridge is mounted therein. In this application the inventive solution ensures that the primer upon reloading the shell case always is correctly positioned for an effective impulse from the firing pin upon firing. In other words, the insert 7 which is insertable into the cartridge compensates for variations in length of the cartridge-seat, thus preventing misfiring of the cartridge. Upon reloading of the shell case, the cartridge is first seated in the cartridge-seat formed in the front portion of the shell case, whereupon the rear portion of the shell case is threaded over the front portion until the rear portion of the cartridge is received through the hole 15. In this position, the rear portion of the shell case rests against a shoulder 19 extended radially between the portion 17 of reduced diameter and the cylindrical container portion of actual cartridge diameter. The insert 7 is depressed into the cartridge at an insertion depth that puts the forward end of the insert into contact with the wall 5 of the cartridge-seat before the rear portion of the shell case is screwed completely onto the front portion. Then, the rear portion is screwed down to its end position, whereby the insert 7 is further depressed into the cartridge thus securing a bearing contact in both ends of the propellant cartridge.

Since, as stated above, the cartridge initially has an oversized but adjustable axial length in relation to the cartridge-seat it will be ensured that the primer 2 always assumes the correct axial position for ignition through the impact by the firing pin. This aspect of the invention may be particularly important with respect to reloading in active service conditions wherein particulate matter in the threaded connection between the shell case portions might obstruct a complete screwing together of the shell case portions.

Through the suggested provision of a constriction of the combustion gas flow in a propellant cartridge will be achieved, that the cartridge itself operates as a high-pressure chamber. Since the constriction is formed in a separate and exchangeable insert there will be provided increased possibilities for optimization of the propellant cartridge with respect to a desired exit velocity, by choosing the proper constriction in order to secure a favorable pressure and resulting temperature in the high-pressure chamber. Further, since the insert has the same external dimension as a bullet caliber matching the cartridge diameter, the cartridge may readily be charged or recharged by the use of conventional reloading tools.